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ORIGINAL ARTICLE

Microdiscectomy compared with standard discectomy: an old problem revisited with new outcome measures within the framework of a spine surgical registry

F. Porchet · V. Bartanusz · F. S. Kleinstueck · F. Lattig · D. Jeszenszky · D. Grob · A. F. Mannion

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Abstract Studies comparing the relative merits of microdiscectomy and standard discectomy report conflicting results, depending on the outcome measure of interest. Most trials are small, and few have employed validated, multidimensional patient-orientated outcome measures, considered essential in outcomes research. In the present study, data were collected prospectively from six surgeons participating in a surgical registry. Inclusion criteria were: lumbar/lumbosacral degenerative disease; discectomy/sequestrectomy without additional fusion/stabilisation; German or English-speaking. Before and 3 and 12 months after surgery, patients completed the Core Outcome Measures Index comprising questions on leg/buttock pain, back pain, back-related function, symptom-specific well-being, general quality-of-life, and social and work disability. At follow-up, they rated overall satisfaction, global outcome, and perceived complications. Compliance with the registry documentation was excellent: 87% for surgeons (surgery forms), 91% for patients (for 12 months follow-up). 261 patients satisfied the inclusion criteria (225 microdiscectomy, 36 standard discectomy). The standard discectomy group had significantly greater blood-loss than the microdiscectomy ($P < 0.05$). There were no group differences in the proportion of surgical complications or duration of hospital stay ($P > 0.05$). The groups did not differ in relation to any of the patient-orientated outcomes or individual outcome domains ($P > 0.05$). Though not equivalent to an RCT, the study included every single eligible patient in our Spine Center and allowed surgeons to use their regular procedure; it hence had extremely high external validity (relevance/generalisability). There was no clinically relevant difference in outcome after lumbar disc excision dependent on the use of the microscope. The decision to use the microscope should rest with the surgeon.

Keywords Microdiscectomy · Standard discectomy · Outcome measures · Spine registry

Introduction

Elective lumbar discectomy is regarded as a good treatment option for lumbar disc herniation if sciatica or neurological deficits occur and still persist after 6 weeks of conservative therapy [6, 8, 19]. Mixter and Barr first described herniated disc as a cause of neural compression in the lumbar spinal canal in 1934 [17]. They described a surgical approach to the problem that involved partial hemilaminectomy and partial removal of the disc. In 1977, a new technology was introduced by Yasargil [24] and Caspar [4] that involved the use of an operating microscope for the surgical removal of the disc. They independently described microsurgical techniques that provided excellent lighting and magnification of the operative field. Compared with the standard open discectomy, the microdiscectomy enabled the use of smaller incisions of the skin and fascia and facilitated a less

F. Porchet · V. Bartanusz
Department of Neurosurgery, Spine Center,
Schulthess Klinik, Lengghalde 2, 8008 Zurich, Switzerland

F. S. Kleinstueck · F. Lattig · D. Jeszenszky · D. Grob
Department of Spine Surgery, Spine Center,
Schulthess Klinik, Lengghalde 2, 8008 Zurich, Switzerland

A. F. Mannion (✉)
Spine Center Division, Department of Research
and Development, Schulthess Klinik, Lengghalde 2,
8008 Zurich, Switzerland
e-mail: anne.mannion@kws.ch

traumatic surgical procedure. The first follow-up report of Williams et al. in 1978 showed encouraging results following lumbar microdiscectomy [23]. Since that time these two procedures have been considered the gold standard for the surgical treatment of lumbar disc herniations.

Retrospective studies [1, 2, 5, 18, 20] and prospective studies [13, 22], some randomised [11, 12, 21], comparing microdiscectomy and standard (open) discectomy techniques report conflicting results regarding the relative merits of the two procedures; however, the general consensus appears to be that they yield broadly comparable outcomes [8, 16]. Although randomised controlled trials are considered to be the pinnacle in the hierarchy of evidence, they often involve only a limited selection of the typical patient population suffering from the condition, and hence have questionable external validity [3, 14]. Further, if surgeons are required to implement a non-preferred or non-familiar technique, solely for the purposes of a comparative trial, then factors concerned with experience and practice may influence the overall outcomes. Another drawback of the aforementioned discectomy trials is that few of them made use of valid, multidimensional patient self-rated outcome measures, now considered essential in outcomes research [7]; instead, they generally tended to focus on operative conditions, clinical signs, complications, and durations of surgery or hospital stay. A number of them measured pain intensity [11, 12, 18, 21, 22], but even this may not suffice to fully capture the overall outcome of the surgery, especially where hypothesised benefits concern the reduced invasiveness of microsurgery, with its potential ramifications for the restoration of function. In order to obviate some of these potential biases, we capitalised on the observational data, collected prospectively from all patients within our Spine Center as part of a surgical registry, to compare multidimensional outcome after lumbar disc excision with and without the use of the microscope.

Methods

Inclusion criteria

The study was carried out within the framework of the SSE Spine Tango Spine Surgery Registry. It included the data of all patients undergoing surgery by one of the six experienced spine surgeons (4 orthopaedic and 2 neurosurgeons) in the Spine Center of a specialised orthopaedic hospital (from Jan 2005 to Feb 2007 inclusive). Patients had to be fluent in either German or English, be at a minimum 1-year post-op, and satisfy the surgical inclusion criteria. The latter were based on the data documented on the registry's "SSE Surgery Form" as follows: main pathology = degenerative disease; level = lumbar, lumbosacral, or sacral; surgical measures = discectomy or sequestrectomy with no additional decompressive techniques and no additional fusion or stabilisation.

The SSE Surgery forms were also used to derive information regarding the use of the microscope (yes = microdiscectomy; no = standard discectomy), operation duration (10 categories, from <1 h to >10 h), blood loss (5 categories: none, <500, 500–1,000, 1000–2,000, >2,000 ml), comorbidity (assessed with the American Society of Anesthesiologists Physical Status Score (ASA Score), from 1 (no disturbance) to 5 (moribund)), surgical complications and general complications, duration of hospital stay.

Patient-orientated questionnaires

Before and 3 and 12 months after surgery, patients were requested to complete the multidimensional Core Outcome Measures Index (COMI) questionnaire [15]. On each occasion, the questionnaires were sent to the patients to complete at home, to ensure that the information given was free of care-provider influence. The COMI is a multidimensional index consisting of validated questions covering the domains of pain (leg/buttock and back pain intensity, each measured separately on a 0–10 graphic rating scale), function, symptom-specific well-being, general quality of life, and social and work disability. In addition to these questions answered both before and 12 months after surgery, at the 12-month follow-up there were further questions inquiring about overall satisfaction with treatment of the back problem in the hospital (5 categories from "very satisfied" to "very dissatisfied"), the global outcome of surgery ("how much did the operation help your back problem?", with 5 categories from "helped a lot" to "made things worse"), and patient-rated complications (yes/no; if yes, describe) [9]. The global outcome was dichotomised into "good" (operation helped, or helped a lot) and "poor" (operation only helped a little, didn't help, made things worse) for the purposes of some of the subsequent analyses.

Statistical analyses

Descriptive data are presented as means ± standard deviations (SD). The significance of the difference between the micro discectomy and standard discectomy groups for continuous, normally-distributed data was analysed using unpaired Students t tests. Contingency analyses were used to analyse the association between surgical group and categorical variables.

Statistical significance was accepted at the $P < 0.05$ level.

Results

Final study group

The system compliance rate for the surgeons' completion of the Surgical Registry Forms was 87%. At baseline, the COMI questionnaire was completed by 87% patients (those missed were predominantly due to administrative errors that occurred during the start-up phase of the registry); 98% of all those that were sent a 3-month questionnaire and 91% of those sent a 12-month follow-up questionnaire returned it complete.

Of the 2,243 patients in the database with 12-month follow-up, 261 patients satisfied the surgical admission criteria (225 in the microdiscectomy group, 36 in the standard discectomy). Their demographic and baseline clinical data are shown in Table 1. There were tendencies for a higher proportion of men, greater co-morbidity, and higher leg pain intensity in the standard discectomy group than in the microdiscectomy group, but the differences were not statistically significant (all $P > 0.05$). There was a significantly higher proportion of patients with private health insurance in the standard discectomy group ($P = 0.04$).

Operation details

The data describing the operation details are shown in Table 2. There was a significantly greater blood-loss in the standard discectomy group ($P < 0.0001$). There were no significant group differences in the operation duration, proportion of general or surgical complications or the overall duration of the hospital stay (each $P > 0.05$).

Table 2 Operation details for the standard discectomy and microdiscectomy groups, as documented using the SSE Spine Tango Spine Surgery form

Variable	Standard discectomy ($N = 225$)	Microdiscectomy ($N = 36$)	P value
Operation duration (%)			
<1 h	61.1%	71.1%	0.37
1–2 h	38.9%	28.0%	
2–3 h	0.0%	0.9%	
Blood loss (%):			
None	11.1%	55.1%	**0.0001**
<500 ml	88.9%	44.4%	
500–1,000 ml	0.0%	0.5%	
Length of hospital stay (days)	5.9 ± 3.0	6.0 ± 2.8	0.95
General complications (intra/perioperative)	2.8%	0.9%	0.32
Surgical complications (intra/perioperative)	2.8%	2.2%	0.84

Outcome

Table 3 shows the outcomes in the two groups, 3 months after surgery. There was no significant difference between the groups in relation to any of the patient-rated outcomes (each $P > 0.05$): global outcome; satisfaction with treatment; prospectively measured *reductions* in back pain, leg

Table 1 Demographic and baseline self-rated clinical data for the standard discectomy and microdiscectomy groups

Variable	Standard discectomy	Microdiscectomy	P value
Number	36	225	
Age (years)	48.0 ± 14.1	50.9 ± 14.1	0.25
Gender	25 men (69%)	120 men (53%)	0.07
	11 women (31%)	105 women (47%)	
Health insurance (%):			
Private	71%	53%	0.04
Basic obligatory	29%	47%	
Comorbidity, ASA score (%)			
I	58%	64%	0.11
II	28%	31%	
III	14%	5%	
IV	0%	0%	
Baseline leg pain intensity* (0–10 scale)	7.6 ± 1.7	6.9 ± 2.5	0.13
Baseline back pain intensity* (0–10 scale)	4.4 ± 2.7	4.5 ± 2.9	0.85
Baseline multidimensional COMI score (0–10 scale)	8.2 ± 1.4	8.0 ± 1.6	0.39

* $N = 227$ patients (198 micro, 29 standard discectomy); baseline data missing for 13% patients

Table 3 Outcome in the microdiscectomy and standard discectomy groups, 3 months after surgery, as documented with the COMI questionnaire

Variable	Standard discectomy	Microdiscectomy	*P* value
Global outcome (%)*			
Good (operation helped/helped a lot)	91.2%	84.9%	0.33
Poor (operation helped only little/didn't help/made things worse)	8.8%	15.1%	
Satisfaction (%)*			
Satisfied (very/somewhat satisfied)	91.2%	88.0%	0.59
Not satisfied (neither satisfied nor dissatisfied/somewhat or very dissatisfied)	8.8%	12.0%	
Reduction in *COMI* multi-dimensional *score*, pre-op to 3-months post-op**	4.9 ± 2.5	3.9 ± 2.7	0.09
Reduction in *back* pain intensity, pre-op to 3-months**	2.1 ± 2.8	2.0 ± 3.1	0.93
Reduction in *leg* pain intensity, pre-op to 3-month**	5.0 ± 3.1	4.3 ± 3.4	0.32
COMI multi-dimensional *score*, at 3-month post-op***	3.6 ± 2.5	3.9 ± 2.7	0.62
Back pain intensity, at 3-month post-op***	2.3 ± 2.1	2.4 ± 2.4	0.85
Leg pain intensity, at 3-month post-op***	2.9 ± 2.5	2.4 ± 2.5	0.32

* $N = 252$ patients (218 micro, 34 standard discectomy); data missing for 3% patients

** $N = 219$ patients (191 micro, 28 standard discectomy); data missing for 16% patients

*** $N = 249$ patients (216 micro, 33 standard discectomy); data missing for 5% patients

Table 4 Outcome in the microdiscectomy and standard discectomy groups, 12 months after surgery, as documented with the COMI questionnaire

Variable	Standard discectomy	Microdiscectomy	*P* value
Global outcome (%)			
Good (operation helped/helped a lot)	85.0%	86.0%	0.82
Poor (operation helped only little/didn't help/made things worse)	15.0%	14.0%	
Satisfaction (%)			
Satisfied (very/somewhat satisfied)	94.4%	88.4%	0.28
Not satisfied (neither satisfied nor dissatisfied/somewhat or very dissatisfied)	5.6%	11.6%	
Patient-rated complications (%)	28.6%	20.9%	0.31
Reduction in *COMI* multi-dimensional *score*, pre-op to 12-month post-op**	5.6 ± 2.1	4.6 ± 2.7	*0.051*
Reduction in *back* pain intensity, pre-op to 12-month**	2.0 ± 2.8	1.8 ± 3.4	0.75
Reduction in *leg* pain intensity, pre-op to 12-month**	5.8 ± 2.5	4.4 ± 3.2	**0.02**
COMI multi-dimensional *score*, at 12-month post-op*	2.9 ± 2.4	3.3 ± 2.7	0.39
Back pain intensity, at 12-month post-op*	2.4 ± 2.1	2.6 ± 2.6	0.63
Leg pain intensity, at 12-month post-op*	2.1 ± 2.6	2.5 ± 2.7	0.44

** $N = 227$ patients (197 micro, 30 standard discectomy), due to missing baseline data for 13% patients preventing the calculation of pre-op to 12-month post-op score changes

pain or COMI multidimensional score (pre-surgery to 3 months post-surgery); *final* values of back pain, leg pain and COMI multidimensional score at 3-months post-surgery.

Table 4 shows the results for the same outcome variables, as well as patient-rated complications, at 12 months post-surgery. There was a similar lack of significant group difference for all outcomes, except for the *reduction* in leg pain intensity, which was significantly more favourable in the standard discectomy group ($P = 0.02$); this appeared to result from the slightly higher initial leg pain values in this group, since the final leg pain intensity did not differ significantly between the groups. The *reduction* in the COMI multidimensional score showed a similar trend (greater

Table 5 Reduction in multidimensional COMI score from before surgery to 12 months after surgery for each sub-category of the baseline demographic data

Variable	N*	Reduction in COMI score, pre-surgery to 12 months post-surgery	P value
Age			
<60	165	4.7 ± 2.8	0.61
>60	60	4.9 ± 2.5	
Gender			
M	124	4.6 ± 2.8	0.44
F	101	4.9 ± 2.7	
Health insurance			
Private	123	5.0 ± 2.5	0.15
Basic obligatory	102	4.4 ± 2.9	
Comorbidity, ASA score (%)			
I (no disturbance)	136	4.8 ± 2.8	0.77
II (mild/moderate)	74	4.5 ± 2.6	
III (severe)	15	4.9 ± 2.6	

* Total $N = 225$ (86%), due to missing baseline data preventing the calculation of pre-op to 12-month post-op score changes

reduction in the standard discectomy group), although this just failed to reach significance ($P = 0.051$).

Additional analyses were carried out to examine whether outcome was influenced by potential confounders that might have differed between the two surgical groups; however, the reduction in COMI multidimensional score showed no significant differences ($P > 0.05$) between any of the sub-categories of the variables comorbidity, gender, age and type of health insurance (Table 5), indicating that any slight differences between the two treatment groups in the distribution of these variables were unlikely to have any influence on the overall results. Similarly, no significant differences between these "potential confounder" sub-categories were seen for satisfaction or global outcome ($P > 0.05$, data not shown).

Discussion

Summary of the main findings

The present study sought to compare operative characteristics and multidimensional outcome after lumbar disc excision with and without the use of the microscope. The study was based on data collected prospectively from patients within our Spine Center as part of a surgical registry. There was a significantly greater blood-loss in the standard discectomy group compared with the microdiscectomy group, but this was the only surgical variable that differed between the groups. Multidimensional outcome measures, assessed prospectively from before surgery to 3 and 12 months after surgery, showed no significant group differences, with the exception of leg pain intensity, which showed a significantly greater *reduction* in the standard discectomy group (pain reduced by 5.8 points) than in the microdiscectomy group (pain reduced by 4.4 points) from pre-surgery to 12 months. Though statistically significant, this 1.4-unit greater reduction in the standard discectomy group lies just below the minimal clinically relevant difference (approximately 1.8 points for a 0–10 pain scale) [10]. At each time point, global outcome and satisfaction tended to be slightly more favourable for the standard discectomy group, but neither showed any statistically or clinically significant group differences and both were extremely positive, at both 3 months and 12 months post-surgery.

Data collection methods and study design

A number of previous studies, both retrospective [1, 2, 5, 18, 20] and prospective [11–13, 21, 22], have served to investigate differences between microdiscectomy and standard discectomy, but none have done so within the confines of a surgical registry. Some of the benefits of the latter are that the medical history, surgical technique and complications are all documented using standardised forms, it includes every medically eligible patient within the Spine Center, and allows surgeons to use their usual preferred operating method. This study design hence bestows an extremely high external validity upon the results. On the other hand, there are certain methodological issues associated with this particular design that could potentially serve to threaten the internal validity of the study and, hence, need to be considered. Firstly, when the different techniques represent the preferred method for given surgeons, it is difficult to establish how much of the difference is accounted for by the individual surgeon's skills per se as opposed to his/her chosen technique. This is, of course, difficult to ascertain, although within our whole registry dataset there was no indication that the

surgeons who preferred microdiscectomy in the present study did any better or worse than those using standard discectomy for indications in which they used the same operative procedure. In this sense, it seems unlikely that differences between the surgeons, per se, had masked or failed to uncover true differences between the techniques. Another factor that could serve to bias the comparison between techniques is the indication for the given procedure; however, the similarity of the baseline data—most notably the comparable scores for the multidimensional COMI—suggested that there were no major differences in the symptom levels guiding the indication for surgery. Other factors with a potential to confound the comparison if differing between the groups—such as age, gender, comorbidity, and type of health insurance—were found to be similarly distributed between the two groups (except for health insurance status) and, more importantly, to have no significant influence per se on the outcome. And, finally, although the group sizes were very different (only one surgeon typically didn't use the microscope), the smallest group size (approximately 40 patients) was still large enough to have given the study sufficient power to detect a clinically meaningful difference between the groups had one existed.

Hence, although the study was not a randomised trial, which would have placed it higher up in the "hierarchy of evidence", the data were considered unlikely to have been subject to any notable bias and the results were highly relevant to clinical everyday practice. It thus possessed "the best of both worlds" i.e., retained many of the benefits of the two types of study design, the randomised trial and the observational study [14].

Surgical data and outcomes compared with previous studies

In terms of the surgical data, the present study showed similar findings to previous studies [2, 18], most notably that despite the smaller incision utilised for microsurgery the increased visualization allowed for a significantly decreased perioperative blood loss compared with standard discectomy. In more than 50% of the microdiscectomy cases there was no noteworthy bleeding, which is an important factor to consider, especially in a younger population, to prevent the need for blood transfusions.

In the present study, the use of the microscope did not lengthen the duration of the operation. This conflicts with the findings of some earlier studies [11, 12, 21, 22] but is in agreement with others, some of which even reported a shorter operation time when using the microscope [2, 18]. This effect is likely related to the better visualisation of the venous vessels in the spinal canal, afforded by use of the microscope. The epidural veins can be seen and targeted for bipolar coagulation rather than being unintentionally cut or ruptured as can happen during standard surgery. With the latter, time is lost with suction and haemostasis to regain a clear view of the neuroanatomy. To get the microscope to the operating table and to get a good view of the operating field requires a well-trained team in the operating theatre. If this condition is not met, then the operating time will undoubtedly increase; it is probably this that accounts for the longer operative times reported for microdiscectomy in some studies [21].

The amount of postoperative epidural scarring at the operative site is believed to be dependent on the amount of tissue manipulation and intraoperative bleeding. As such, it would have been expected that, in our series, the standard discectomy group would have had a less good outcome. However, this was not the case. In contrast, the reduction in leg pain intensity from baseline to 12 months was significantly greater in the standard discectomy than the microdiscectomy group, and all other outcome measures measured *at* the 12- month follow-up (COMI multidimensional score, back pain intensity and leg pain intensity, global outcome and satisfaction) did not show any statistically significant differences between the groups. This concurs with the recently published results of Katayama et al. who demonstrated in their randomised trial that both microdiscectomy and macrodiscectomy were appropriate techniques with no difference in outcomes as far as VAS scores for sciatica, analgesic use, and Japanese Orthopaedic Association scores were concerned [12]. In two studies, an earlier return to work/normal activities [18, 22] with less postoperative wound pain [18] and less reliance on postoperative analgesics [22] was reported for microdiscectomy compared with standard discectomy, and this was explained by the correspondingly reduced tissue trauma during microsurgery. We cannot pass comment on these outcomes, since we did not examine the use of medication after surgery, and the return to work time after this surgical procedure is relatively standardised in our hospital and country; however, none of the early (3-month) results for the various outcome domains showed any suggestion of a more rapid return to "normal life" in the microdiscectomy group. Return to work is renowned for being an outcome that is strongly influenced by differences in the worker's compensation politics in different countries, making difficult any comparisons between studies in this respect. Some studies have reported a reduced hospital stay after microdiscectomy compared with standard discectomy [18] although the opposite has also been found [12]; however, this variable, too, is often dependent on factors other than the "medical" readiness to return home (such as the healthcare policies and insurance systems in the given country), and is hence not the best measure of the invasiveness of the surgery or the recovery rate of the patient.

Summarising, our study showed that, with respect to patient-rated outcomes, there was no difference between the classical macroscopic approach to lumbar disc herniation and the more modern microdiscectomy using the operative microscope. This raises an important concern regarding the justification for financing the plethora of emerging tools for minimally invasive spinal surgery. Spine surgery is an extremely rapidly evolving subspecialty, and new approaches and instrumentations are constantly being developed which are intended—based on logical reasoning—to result in better patient care. Our study illustrates how such reasoning is not always substantiated in practice, when evaluated on a scientific basis. For this reason, it is more important than ever that our management decisions in spine surgery are based on strict evidence-based criteria.

In conclusion, although not equivalent to an RCT, the present study included every single eligible patient in our Spine Center and allowed surgeons to use their regular procedure; it hence had extremely high external validity (relevance/generalisability). The use of the microscope did not prolong the operation duration, yet it did result in significantly less blood loss. Other purported benefits of the use of the microscope include its superiority in teaching younger colleagues (same view for all, which is not possible with standard discectomy); the tool may therefore facilitate a more rapid acquisition of higher surgical standards. In terms of patient-rated outcomes, however, there appears to be no particular advantage to either technique. Both result in a good overall outcome when the surgeon is adept in his/her own chosen method; the decision to use the microscope should hence rest with the individual surgeon.

Conflict of interest statement None of the authors has any potential conflict of interest.

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